

## Product Features

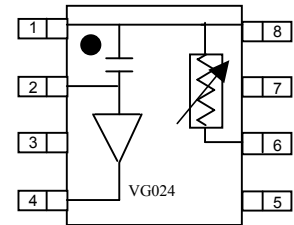
- 50 – 2200 MHz bandwidth
- 17 dB Attenuation Range
- +37 dBm Output IP3
- +21 dBm P1dB
- Constant IP3 & P1dB over attenuation range
- Single voltage supply for DC and RF circuit
- SOIC-8 package w/ heat slug
- MTTF > 100 years

## Product Description

The VG024 is a wideband high dynamic range variable gain amplifier (VGA) packaged in a SOIC-8 surface-mount package. The +21 dBm output compression point and +37 dBm output intercept point of the amplifier are maintained over the entire attenuation range, making the VG024 ideal for use in temperature compensation circuits. With the suggested driver circuit there can be independent gain slope and offset control for compensating RF chains with many amplifier stages. Other attenuator driver circuits give more functionality to this MCM and can be found in the application notes.

Superior thermal design allows the product to have a minimum MTTF rating of 100 years at a mounting temperature of +85° C. All devices are 100% RF & DC tested and packaged on tape and reel for automated surface-mount assembly.

## Functional Diagram



Top View

Function	Pin No
Gain Control	1
RF Input	6
Interstage Match	2, 7, 8
RF Output / DC bias	4
Ground	3, 5

## Specifications

Parameters	Units	Min	Typ	Max	Conditions
Frequency Range	MHz	50		2200	See note 1
Gain at min. attenuation	dB	14	15		
Input Return Loss	dB		-10		
Output Return Loss	dB		-10		
Output P1dB	dBm		+21		
Output IP3	dBm		+37		See note 2
Noise Figure at min. attenuation	dB	5.0	5.5	7.2	$V_{A,CTRL} = 0$ V See note 3
Gain Variation Range	dB		17		See note 4
Supply Voltage	V		+5		
Operating RF Amplifier Current Range	mA	120	150	180	Pin 4
Gain Control Pin Current Range	mA	0		25	Pin 1 draws no current at maximum gain
Thermal Resistance	°C / W			59	
Junction Temperature	°C			160	See note 5

Test conditions unless otherwise noted.

1. T = 25°C, V<sub>dd</sub> = +5 V, Frequency = 800 MHz in an application circuit.

2. 3OIP measured with two tones at an output power of +10 dBm/tone separated by 10 MHz. The suppression on the largest IM3 product is used to calculate the 3OIP using a 2:1 rule.

3. Frequency 240-1000 MHz max 6dB at 70 MHz and 7dB at 2.2 GHz T = 25°C

4. Frequency 70-1000 MHz min gain control pin current 15mA 11 dB at 2.2 GHz depending on maximum gain control pin current

5. The max junction temperature ensures a minimum MTBF rating of 1 million hours of usage.

## Absolute Maximum Rating

Parameters	Rating
Operating Case Temperature	-40 to +85 °C
Storage Temperature	-55 to +125 °C
Amplifier Supply Voltage (pin 4)	+6 V
Gain Pin Control Current (pin 1)	+30 mA
RF Input Power (continuous)	+12 dBm
Maximum Junction Temperature	+220° C

Operation of this device above any of these parameters may cause permanent damage.

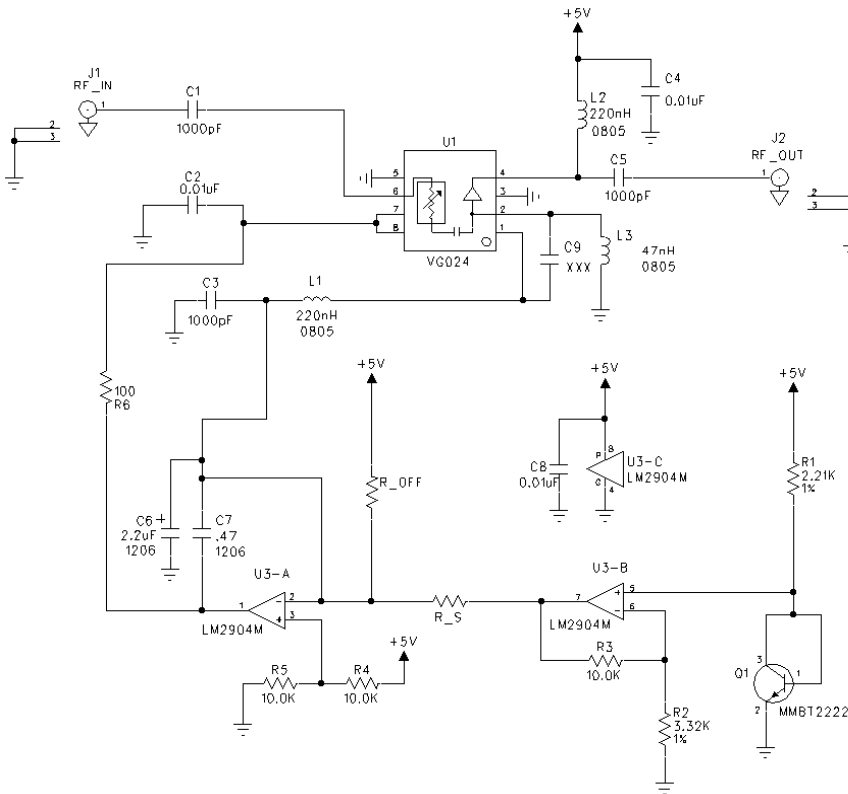
## Ordering Information

Part No.	Description
VG024	Wide-band Variable Gain Amplifier
VG024-PCB-240	Fully Assembled IF Application Board
VG024-PCB-2000	Fully Assembled PCS / UMTS Application Board

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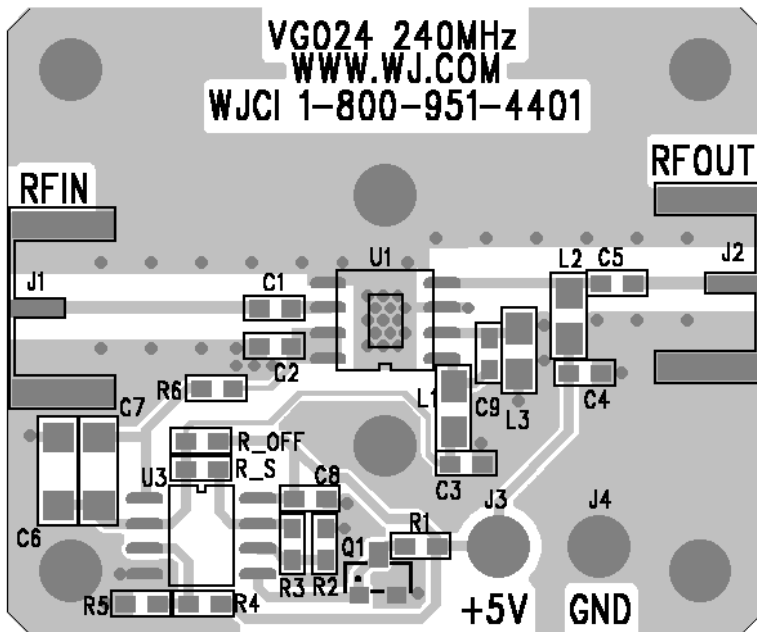
### Temperature Compensation Application Circuit: 240 MHz



#### Bill of Materials

Ref. Des.	Description
C1, C3, C5	1000 pF Chip Capacitor
C2, C4, C8	0.01 μF Chip Capacitor
C6	2.2 μF 1206 Chip Capacitor
C7	0.47 μF 1206 Chip Capacitor
C9	Do Not Load
L1, L2	220 nH 0805 Chip Inductor
L3	47 nH 0805 Chip Inductor
R1	2.21 KΩ Chip Resistor
R2	3.32 KΩ Chip Resistor
R3, R4, R5	10.0 KΩ Chip Resistor
R6	100 Ω Chip Resistor
Roffset	0603 chip Resistor
Rslope	0603 chip Resistor
Q1	MMBT2222A Motorola Transistor
U1	VG024 Variable Gain Amplifier
U2	LM2904 Dual Op Amp

### Evaluation Board Layout



### Functional Pin Layout

Pin	FUNCTION
1	Gain control pin
2	Interstage Match
3	GND
4	RF Output / Bias
5	GND
6	RF Input
7	Interstage Match
8	Interstage Match

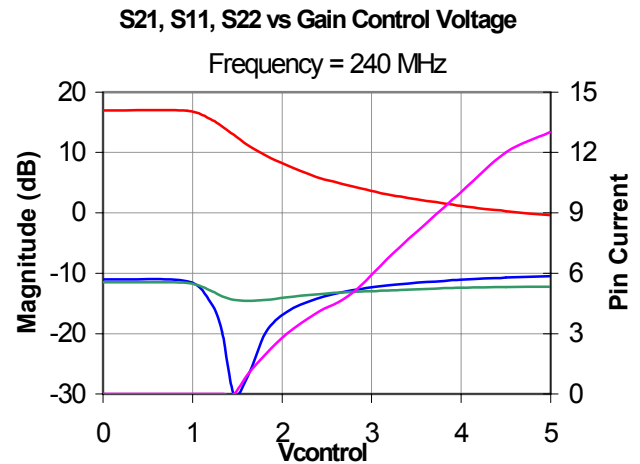
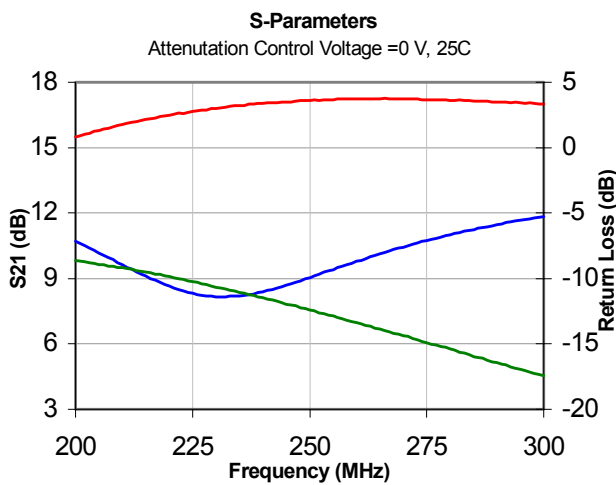
- The amplifier is biased through Pin 4 and should be connected directly into a voltage regulator.

Circuit Board Material:  
 .014" FR-4, 4 layers  
 .062" total thickness

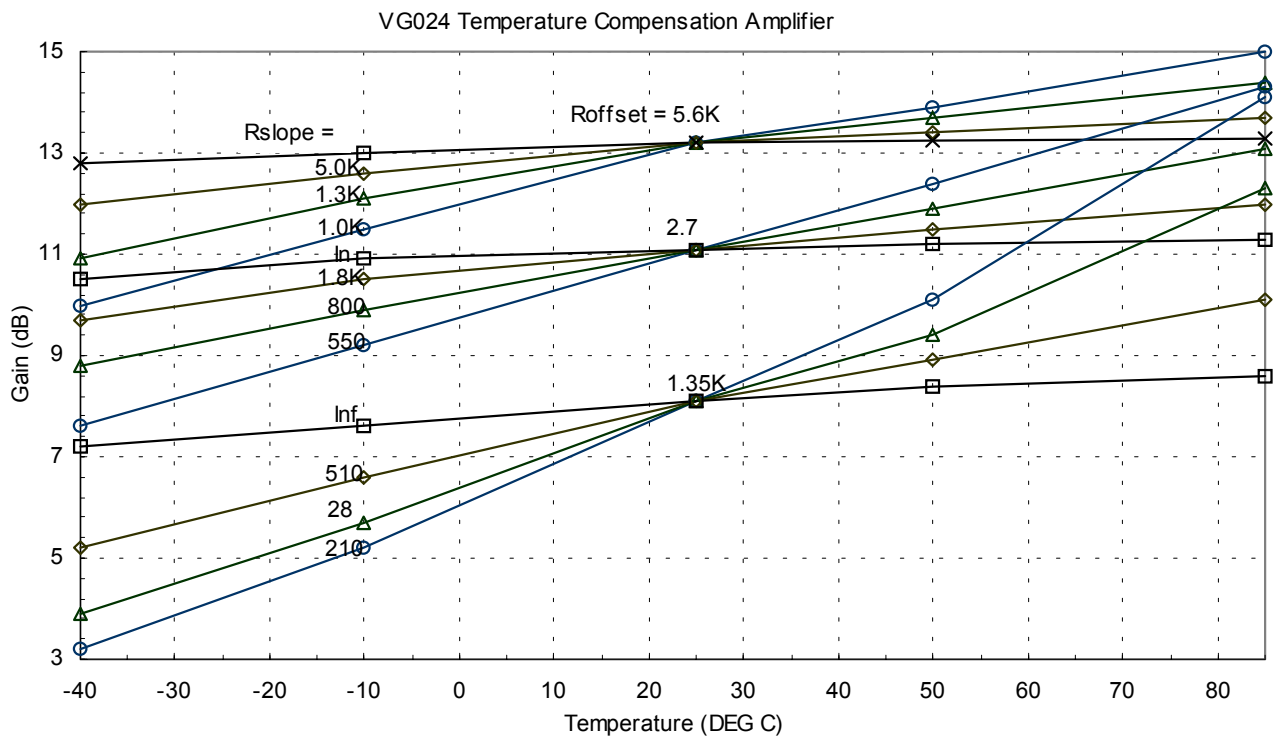
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### Typical Performance Charts: 240 MHz Application Circuit



Vcontrol voltage can be applied to the base of an NPN transistor with the collector connected to the +5V and a 240 ohm current limiting resistor to drive the VG024 as a VGA. This data is represented at 240 MHz in the above graph. Normalized performance can be obtained for the RF circuit tuned from 70-1000 MHz using the temperature compensation application circuit for 240 MHz shown on the previous page. Reducing Roffset increases the overall insertion loss and allows more change (reduction in the value) in Rslope to compensate for more amplifiers or larger temperature changes.





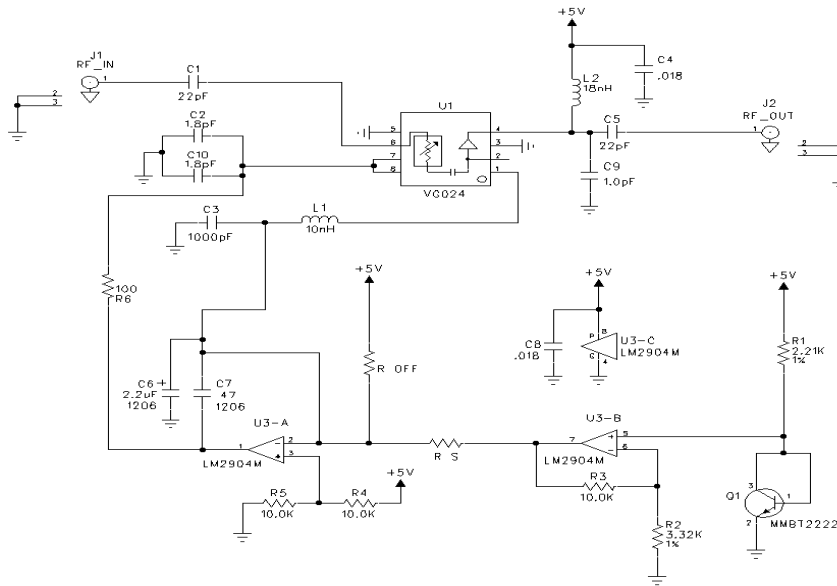
# VG024

## Wide-band Variable Gain Amplifier

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Product Information

### Application Circuit: 2.2 GHz

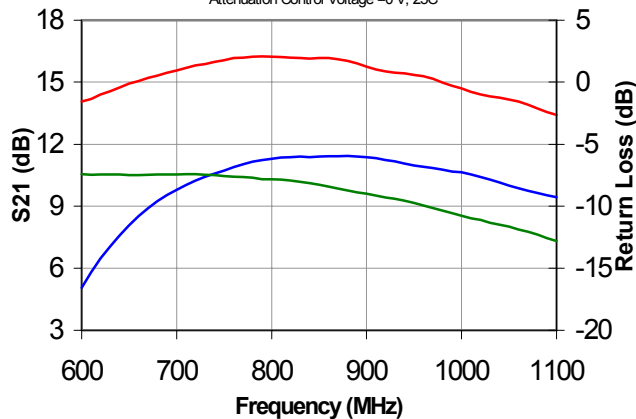


#### Bill of Materials

Ref. Des.	Description
C1, C5	22 pF Chip Capacitor
C2, C10	1.8 pF Chip Capacitor
C3	1000 pF Chip Capacitor
C4, C8	0.01 μF Chip Capacitor
C6	2.2 μF 1206 Chip Capacitor
C7	0.47 μF 1206 Chip Capacitor
L1	10 nH Chip Inductor
L2	18 nH Chip Inductor
R1	2.21 KΩ Chip Resistor
R2	3.32 KΩ Chip Resistor
R3, R4, R5	10.0 KΩ Chip Resistor
R6	100 Ω Chip Resistor
Roffset	0603 chip Resistor
Rslope	0603 chip Resistor
Q1	MMBT2222A Motorola Transistor
U1	VG024 Variable Gain Amplifier
U2	LM2904 Dual Op Amp

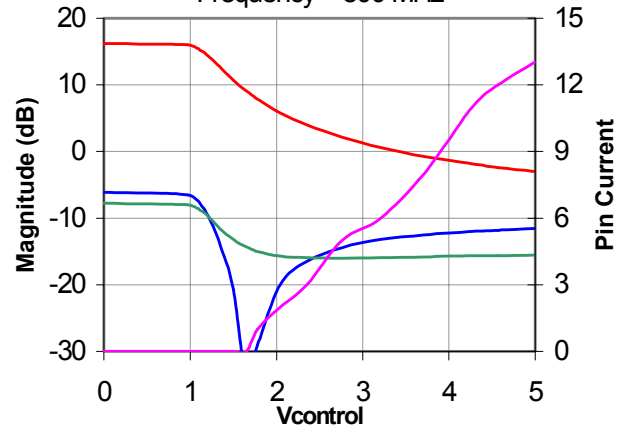
#### S-Parameters

Attenuation Control Voltage = 0 V, 25C



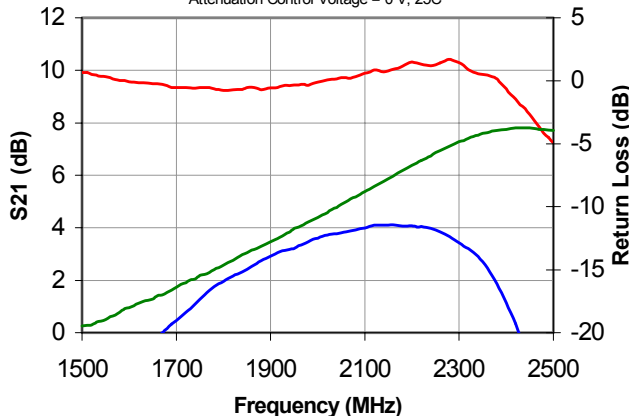
#### S21, S11, S22 vs Gain Control Voltage

Frequency = 800 MHz



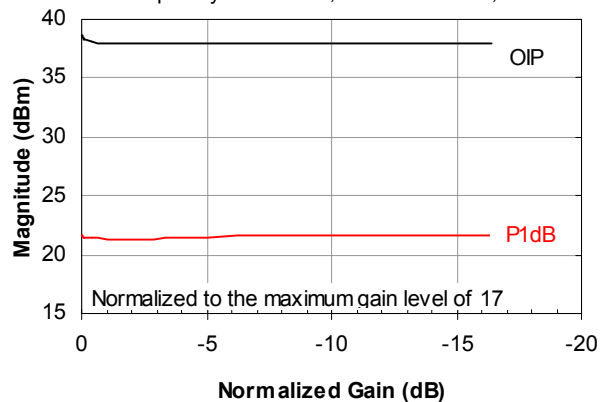
#### S-Parameters

Attenuation Control Voltage = 0 V, 25C



#### OIP3 / P1dB vs. Normalized Gain

frequency = 900 MHz, Pout = +10 dBm, 25°C



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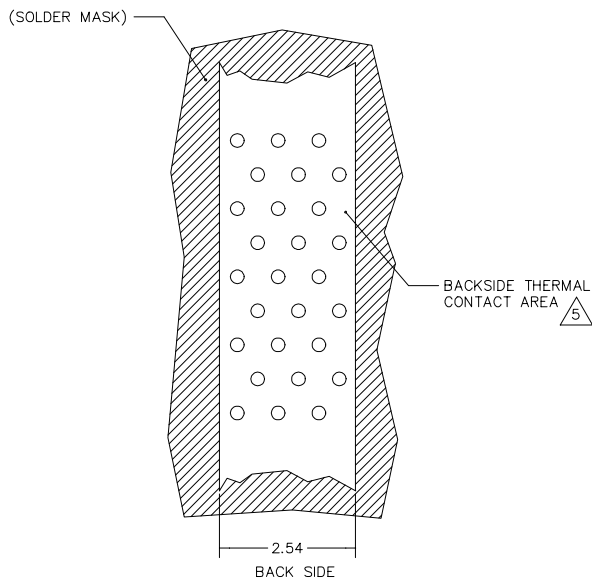
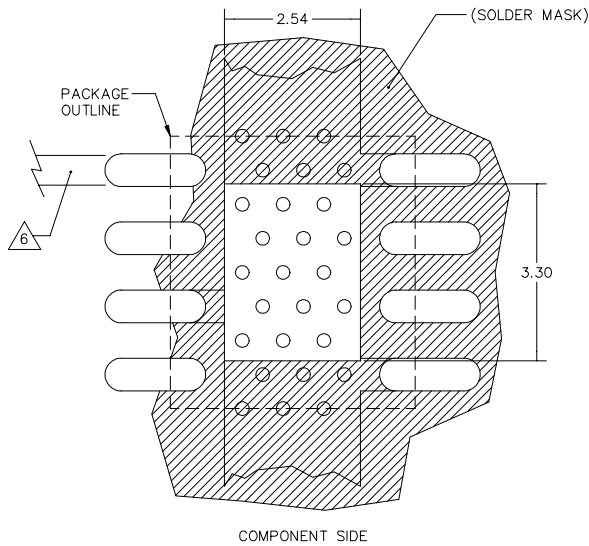
# VG024

## Wide-band Variable Gain Amplifier

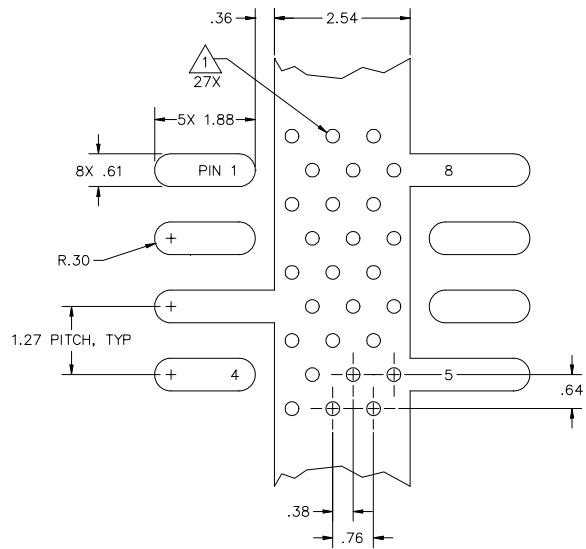
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Product Information

### Mounting Configuration



### Land Pattern



#### NOTES:

1. GROUND/THERMAL VIAS ARE CRITICAL FOR THE PROPER PERFORMANCE OF THIS DEVICE. VIAS SHOULD USE A .35mm (#80/.0135") DIAMETER DRILL AND HAVE A FINAL, PLATED THRU DIAMETER OF .25mm (.010").
2. ADD AS MUCH COPPER AS POSSIBLE TO INNER AND OUTER LAYERS NEAR THE PART TO ENSURE OPTIMAL THERMAL PERFORMANCE.
3. TO ENSURE RELIABLE OPERATION, DEVICE GROUND PADDLE-TO-GROUND PAD SOLDER JOINT IS CRITICAL.
4. ADD MOUNTING SCREWS NEAR THE PART TO FASTEN THE BOARD TO A HEATSINK. ENSURE THAT THE GROUND/THERMAL VIA REGION CONTACTS THE HEATSINK.
5. FOR OPTIMAL THERMAL PERFORMANCE, EXPOSE SOLDERMASK ON BACKSIDE WHERE IT CONTACTS THE HEATSINK.
6. RF TRACE WIDTH DEPENDS UPON THE PC BOARD MATERIAL AND CONSTRUCTION.
7. USE 1 OZ. COPPER MINIMUM.
8. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.

ESD Classification: Class 1B  
 Value: Passes 600 V  
 Test: Human Body Model (HBM)  
 Standard: JEDEC Standard JESD22-A114

ESD Classification: Class IV  
 Value: Passes 1000 V  
 Test: Charged Device Model (CDM)  
 Standard: JEDEC Standard JESD22-C101

MSL Rating: Level 3  
 Standard: JEDEC Standard J-STD-020A

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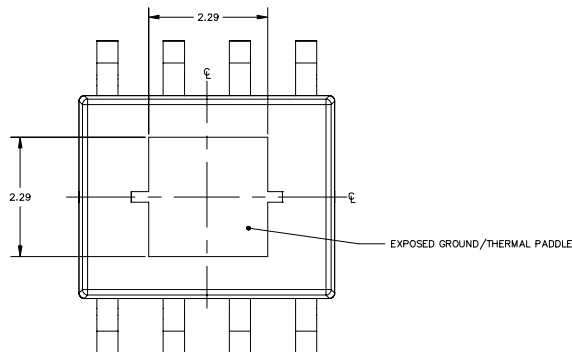
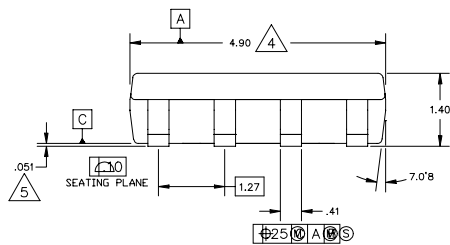
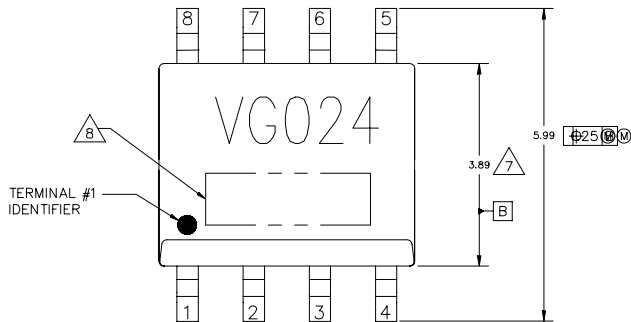
# VG024

Wide-band Variable Gain Amplifier

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Product Information

## Outline Drawing



### NOTES:

1. EXCEPT WHERE NOTED, THIS PART OUTLINE CONFORMS TO JEDEC STANDARD MS-012, ISSUE C FOR SMALL OUTLINE (SO) PERIPHERAL TERMINAL 3.75mm BODY WIDTH (PLASTIC).

2. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.4M-1994.

3. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.

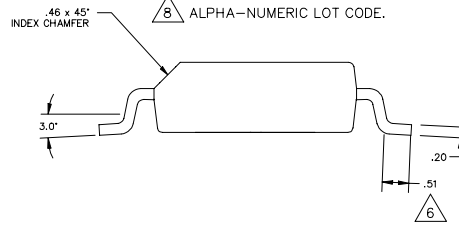
4. DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS, WHICH SHALL NOT EXCEED .25mm PER SIDE.

5. DEVIATION FROM JEDEC MS-012 STANDARD (.10 TO .25).

6. LENGTH FOR SOLDERING TO A SUBSTRATE.

7. DOES NOT INCLUDE INTER-LEAD FLASH OR PROTRUSIONS, WHICH SHALL NOT EXCEED .25mm.

8. ALPHA-NUMERIC LOT CODE.



## Product Marking

The component will be lasermarked with a "VG024" designator with a four-digit alphanumeric lot code on the top surface of the package. Tape and reel specifications for this part will be located on the website in the "Application Notes" section.

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